AVIATION PHYSIOLOGISTS BULLETIN

United States Army Air Forces

1.

April 1943

Air Surgeon's Office

Headquarters Army Air Forces

Washington, D. C.

Recognizing the pioneer character of the Altitude Training Program it has been deemed desirable to provide a suitable medium for the dissemination of information among those engaged in its operation. This is the purpose of the AVIATION PHYSIOLOGISTS BULLETIN. In order that it may fulfill its useful functions, Aviation Physiologists and Flight Surgeons are invited to submit for publication appropriate material growing out of their personal experiences and local conditions. Such contributions should be transmitted through channels to the Office of the Air Surgeon.

Publication of material in this Bulletin is not to be construed as authority for the adoption of procedures or instrumental aids.

* * * * *

AVIATION PHYSIOLOGISTS

With the establishment of the Altitude Training Program the procurement of personnel for its operation became an important problem. The employment of medical officers was an obvious solution, but there were two objections. It was assumed that medical officers would be more interested in the practice of their profession than in the mere physiological aspects of the program. It was furthermore recognized that the urgent need for officers qualified for the practice of medicine would ultimately preclude the use of such personnel for duty if others not qualified for medical practice were available. It was accordingly decided to recruit officers with a broad training in the physiological sciences who had completed the requirements for the degree of Doctor of Philosophy.

From the outset it was realized that the success of this pioneer undertaking would depend less on formal direction and more on the selection of personnel with a broad scientific training, versatile adaptability, and suitable personalities. The choice of personnel has accordingly been made only after the most careful

examination of each applicant's personal and professional qualifications, based on a careful evaluation of the opinions of outstanding scientists familiar with the applicant.

In addition to these officers a certain number of medical officers who have had training in physiology have been assigned to this duty. Some of those who are better qualified for the practice of medicine may ultimately be reassigned to clinical duties when replacements are available.

In a directive from the Air Surgeon's Office in June 1942 there was established a program for the training of Aviation Physiologists. It has been the purpose of this course to give officers with a previous training in the physiological sciences a survey of the physiological problems involved in military aviation, a review of those phases of fundamental physiology dealing with those problems, a familiarity with the objectives of the Altitude Training Program, the practical operation of that program, and the fundamentals of military science.

After consultation with the Commandant of the School of Aviation Medicine it was decided to issue a certificate of graduation upon completion of this course of training. There was thus initiated for the first time in the history of this Country -- probably of the world -- a formal recognition and classification of physiologists as being professionally qualified for specific duties in military aviation.

The Aviation Physiologists commissioned and qualified up to this time are given in the following lists:

Class I, Beginning July 6, 1942.

Name and Rank	Degree	Station
Nicholson, Haydon C., Capt. M.C.	M.D. 1929, Michigan	San Antonio Aviation Cadet Center
Bullen, Halsey, 1st Lt., M.C.	M.D. 1941, Pennsylvania	Salt Lake City AAB
Cumings, Harry W., 1st Lt., A.C.	Ph. D. 1940, Illinois	Tyndall Field, Florida
Evans, Hiram J., 1st Lt., A.C.	Ph. D. 1942, Harvard	Topeka AAB, Kansas

Name and Rank	Degree	Station
Guest, Maurice M., 1st Lt., A. C.	Ph. D. 1941, Columbia	McCarran Field, Nevada
Kleinholz, Lewis H., 1st Lt.,A.C.	Ph. D. 1937, Harvard	Buckingham Field, Florida
Masland, Richard L., 1st Lt.,M.C.	M.D. 1935, Pennsylvania	S. A. M. Randolph Field
Reynolds, S.R.M., 1st Lt., A. C.	Ph. D. 1931, Pennsylvania	S. A. M. Randolph Field
Barry, Alexander, 2nd Lt., A. C.	Ph. D. 1938, Harvard	March Field, California
Biddulph, Clyde, 2nd Lt., A. C.	Ph. D. 1940, Wisconsin	Cochran Field, Georgia
Copeland, Eugene D.,2nd Lt.,A.C.	Ph. D. 1941, Harvard	Peterson Field, Colorado
Fulton, George P., 2nd Lt., A.C.	Ph. D. 1941, Boston U.	San Antonio Aviation Cadet Center
Gray, Stephen W., 2nd Lt., A.C.	Ph. D. 1939, Illinois	Tyndall Field, Florida
Lyman, Charles P., 2nd Lt., A.C.	Ph. D. 1942, Harvard	Fort Shafter, T. H.
Marbarger, John P., 2nd Lt.,A.C.	Ph. D. 1941, Hopkins	Mayo Clinic
Michalski, Joseph V.,2nd Lt.,A.C.	Ph. D. 1942, Princeton	March Field, California
Schiffrin, Milton J.,2nd Lt.,A.C.	Ph. D. 1941, McGill	Albrook Field, C. Z.
Wilber, Charles G., 2nd Lt., A.C.	Ph. D. 1942, Hopkins	Hamilton Field, California
Zinn, Donald J., 2nd Lt., A. C.	Ph. D. 1942, Yale	McCarran Field, Nevada
Rosenthal, Theodore B., Sgt.	Ph. D. 1941, Yale	S. A. M. Randolph Field
Churney, Leon, Pvt.	Ph. D. 1940, Pennsylvania	S. A. M. Randolph Field
Dent, James N., Pvt.(now 2nd Lt.)	Ph. D. 1941, Hopkins	Borrinquen Field, P.R.

Class II, Beginning August 9, 1942.

Name and Rank	Degree	Station
Pierce, Harold F., Major, Sn. C.	M.D. 1935, Hopkins	B. S. A. M., San Antonio, Texas
Barrick, Lewis E., 1st Lt., M.C.	M.D. 1940, Northwest	Deceased
Bradley, Wm. B., 1st Lt., A. C.	Ph. D. 1938, Northwest	Selman Field, Louisiana
Dickson, Dale D., 1st Lt., M.C.	M.D. 1932, Indiana	Bolling Field, D. C.
Eagle, Edward, 1st Lt., A. C.	Ph. D. 1940, Chicago	Harlingen AGS, Texas
Handy, Vincent H., Capt., M. C.	M.D. 1939, Harvard	Tyndall Field, Florida

Name and Rank	Degree	Station
McIver, John M., 1st Lt., M.C.	M.D. 1939, Boston	Harlingen AGS, Texas
Nester, Henry G., 1st Lt., A.C.	Ph. D. 1930, Indiana	Maxwell Field, Alabama
Osborn, Clinton M., 1st Lt., A.C.	Ph. D. 1938, Harvard	McCarran Field, Nevada
Parrack, Horace O., 1st Lt., A.C.	Ph. D. 1939, Columbia	Selman Field, Louisiana
Walker, Roland, 1st Lt., A. C.	Ph. D. 1934, Yale	Harlingen AGS, Texas
Bishop, David W., 2nd Lt., A. C.	Ph. D. 1942, Pennsylvania	Columbia AAB, S. C.
Davenport, Demerest, 2nd Lt.,A.C.	Ph. D. 1937, Harvard	McChord Field, Washington
Decker, John P., 2nd Lt., A. C.	Ph. D. 1942, Duke	Westover Field, Mass.
Hartung, E. W., Jr.,2nd Lt., A.C.	Ph. D. 1942, Harvard	Ellington Field, Texas
Hunter, Francis R., 2nd Lt., A.C.	Ph. D. 1936, Princeton	Davis-Monthan Field, Arizona
Law, Lloyd W., 2nd Lt., A. C.	Ph. D. 1937, Harvard	Salt Lake City AAB, Utah
Shelden, Frederick F.,2nd Lt.,A.C.	Ph. D. 1940, California	Ellington Field, Texas
Zeiner, Frederick N., 2nd Lt.,A.C.	Ph. D. 1942, Indiana	Peterson Field, Colorado
Lomangino, Thomas F., Pvt.	B. S., Allegheny	S. A. M. Randolph Field

Class III, Beginning September 27, 1942.

Name and Rank	Degree	Station
Baker, Richard B., 1st Lt., M.C.	M.D. 1939, Harvard	Selman Field, Louisiana
Monke, Victor J., 1st Lt., A. C.	Ph. D. 1942, Maryland	Salt Lake City AAB Utah
Pastorius, George J., 1st Lt.,M.C.	M.D. 1935, Pittsburgh	Topeka AAB, Kansas
Rakieten, Nathan, 1st Lt., A. C.	Ph. D. 1933, Yale	Topeka AAB, Kansas
Sleeth, C. K., 1st Lt., M. C.	M.D. 1938, Chicago	Harlingen AGS, Texas
Taylor, Charles B., 1st Lt., M.C.	M.D. 1941, Minnesota	Mayo Clinic
Toth, L. H., 1st Lt., A. C.	Ph. D. 1936, Rochester	McCarran Field, Nevada
Maaske, Clarence A.,2nd Lt., A.C.	Ph. D. 1941, Wisconsin	Aero Medical Laboratory
Moreland, Ferrin B.,2nd Lt., A.C.	Ph. D. 1936, Vanderbilt	Maxwell Field, Alabama
Smith, Ralph I., 2nd Lt., A. C.	Ph. D. 1942, Harvard	Maxwell Field, Alabama
Grumbach, Leonard G., T/4th Gr.	Ph. D. 1939, Cornell	S. A. M. Randolph Field

no. 1

Name and Rank	Degree	Station
McNutt, Clarence W., Pvt.	Ph. D. 1941, Brown	S. A. M. Randolph Fi[illegible]

Class IV, Beginning November 9, 1942.

Leick, Richard M., Capt., M.C.	M.D. 1936, Minnesota	McCarron Field, Nevada
Peterson, Ward A., Capt., M.C.	M.D. 1929, Creighton	Salt Lake City AAB, Utah
Bachrach, William H., 1st Lt.,M.C.	M.D. 1940, Northwest	MacDill Field, Florida
Chinard, Francis P., 1st Lt., M.C.	M.D. 1941, Hopkins	8th AF, England
Hafkenschiel, Joseph, 1st Lt.,M.C.	M.D. 1941, Hopkins	Pyote AAB, Pyote, Texas
Knowlton, George C., 1st Lt., A.C.	Ph. D. 1934, Iowa	Selfridge Field, Mich.
Mackenzie, Cosmo G., 1st Lt., A.C.	Ph. D. 1936, Hopkins	Greenville AAB, S. C.
Maurer, Wm. S., 1st Lt., M. C.	M.D. 1938, Yale	Dale Mabry Field, Florida
Mazia, Daniel, 1st Lt., A. C.	Ph. D. Pennsylvania	Gowen Field, Idaho
Reynolds, Albert E., 1st Lt.,A.C.	Ph. D. 1941, Chicago	Cochran Field, Georgia
Robinson, True W., 1st Lt., A.C.	Ph. D. 1937, Harvard	Aero Medical Laborat[illegible]
Swann, Howard G., 1st Lt., A. C.	Ph. D. 1935, Chicago	Kingman AGS, Texas
Winter, Irwin C., 1st Lt., M. C.	M.D. 1941, Tennessee	Buckingham Field, Florida
Baker, Edgar G. S., 2nd Lt., A.C.	Ph. D. 1943, Stanford	Tyndall Field, Florid[illegible]
Harris, John E., 2nd Lt., A. C.	Ph. D. 1940, Iowa	Ephrata AAB, Washingt[illegible]
Krause, Reginald F., 2nd Lt.,A.C.	Ph. D. 1942, Rochester	Barksdale Field, Louisiana
Lane, Charles E., 2nd Lt., A. C.	Ph. D. 1935, Wisconsin	Mitchell Field, N. Y.
Treat, Asher E., 2nd Lt., A. C.	Ph. D. 1941, Columbia	San Antonio Aviation Cadet Center
Kritzler, Henry, Pvt.		

Class V, Beginning December 21, 1943

Name and Rank	Degree	Station
Hammond, James, Major, M. C.	M.D. 1937, Oklahoma	Headquarters Third Air Force
Kenney, Vernon C., Capt., M.C.	M.D. 1929, Northwest	Santa Ana AAB, California

No. 1

Name and Rank	Degree	Station
Schmidt, Clarence R., Capt. M.C.	M.D. 1939, Northwest	Walla Walla AAB, Washington
Sweeney, Henry M., Capt., A. C.	Ph. D. 1934, Tulane	Aero Medical Laboratory
D'Angelo, Savina A., 1st Lt., A.C.	Ph. D. 1940, N. Y. U.	MacDill Field, Florida
DeYarman, Kyle T., 1st Lt., M.C.	M.D. 1939, Iowa State	San Antonio Aviation Cadet Center
Grossman, Bernard B., 1st Lt., M.C.	M.D. 1936, Texas	San Antonio Aviation Cadet Center
Koontz, Arch C., 1st Lt., M. C.	M.D. 1935, Texas	Zachery Field, Laredo, Texas
Miller, Louis, 1st Lt., M.C.	M.D. 1936, Ohio State	Maxwell Field, Alabama
Meyers, John, 1st Lt., M. C.	M.D. 1936, Boston	Ellington Field, Texas
Norris, George L., 1st Lt., M. C.	M.D. 1940, Kansas	Santa Ana AAB, California
Schwartzberg, Samuel, 1st Lt., M.D.	M.D. 1929, Texas	Zachery Field, Laredo, Texas
Lansing, Albert I., 2nd Lt., A.C.	Ph. D. 1941, Indiana	McChord Field, Washington
Peskin, James C., 2nd Lt., A. C.	Ph. D. 1941, Columbia	Orlando AAB, Florida
Stableford, Louis T., 2nd Lt., A.C.	Ph. D. 1941, Yale	Topeka, AAB, Kansas
Grave, Caswell, Pvt.		S. A. M. Randolph Field
Sherman, Frederick G., Pvt.	Ph. D. 1942, Northwest	S. A. M. Randolph Field

Class VI, Beginning January 25, 1943

Name and Rank	Degree	Station
Barnes, Broda O., Capt. M. C.	M.D. 1937, Rush Medical	Kingman AGS, Arizona
Crisler, Geo. R., Capt. M. C.	M.D. 1931, Chica go	Santa Ana AAB, California
MacCardle, Ross C., Capt., A. C.	Ph. D. 1932, Brown	Aero Medical Laboratory
Beinstein, Joseph, 1st Lt., M.C.	M.D. 1940, Pennsylvania	Maxwell Field, Alabama
Gompertz, Michael L., 1st Lt., M.C.	M.D. 1937, Columbia	Santa Ana AAB, California
Gravett, Howard L., 1st Lt., A.C.	Ph. D. 1939, Illinois	Bolling Field, District Columbia
Hartnett, Eugene M., 1st Lt., M.C.	M.D. 1939, Georgetown	Peterson Field, Colorado
Klanke, Charles W., 1st Lt., M. C.	M.D. 1932, Texas	Buckingham Field, Florida
Korman, Samuel, 1st Lt., Sn. C.	Ph. D. 1936, Columbia	Avon Park B. R., Florida

Name and Rank	Degree	Station
Lindauer, Max A., 1st Lt., M. C.	M.D. 1931 Pennsylvania	Westover Field, Massachusetts
Ollayos, Robert W., 1st Lt.,M.C.	M.D. 1941, Yale	Gowen Field, Idaho
Rogers, Frederick F., 1st Lt.,M.C.	M.D. 1940, Texas	Pyote AAB, Texas
Schultz, Fred H., 1st Lt., A.C.	Ph. D. 1938, Colorado	Zachery Field, Laredo, Texas
Smith, Robert W., 1st Lt., M.C.	M.D. 1938, Vanderbilt	Kingman AGS, Arizona
Sperry, Frederick S., 1st Lt.,M.C.	M.D. 1941, Iowa State	Mitchell Field, New York
Weeks, William F., 1st Lt., M.C.	M.D. 1941, Michigan	Cochran Field, Georgia
Wilkinson, Geo. W., 1st Lt.,M.C.	M.D. 1941, Iowa State	Selman Field, Louisiana
Wilson, Edward T., 1st Lt., M.C.	M.D. 1942, Northwest	S. A. M. Randolph Field (otitis media)
Zahrt, 1st Lt., M. C.	M.D. 1941, Iowa State	San Antonio Aviation Cadet Center
DeLanney, Louis E. 2nd Lt., A.C.	Ph. D. 1940, Stanford	Hamilton Field, California
Drury, Horace F., 2nd Lt., A. C.	Ph. D. 1940, Harvard	Ephrata AAB, Washington
Edgerley, R. H., 2nd Lt., A. C.	Ph. D. 1942, Ohio State	Gowen Field, Idaho
Opton, Edward W., 2nd Lt., A. C.	Ph. D. 1943, Yale	Dale Mabry Field, Florida
Rodbard, Simon, 2nd Lt., A. C.	Ph. D. 1941, Chicago	Davis-Monthan Field, Arizona
Spratt, Nelson T., 2nd Lt., A.C.	Ph. D. 1940, Rochester	Barksdale Field, Louisiana
Shaver, John R., Pfc.		S. A. M. Randolph Field

* * * * *

THE EFFECTS OF ANOXIA ON VISION

The impairment of vision that results from anoxia is of great practical importance to flying personnel. It is also of scientific interest to the aviation physiologist, for it furnishes him with a delicate measure of anoxic disorders. The graying out, or darkening, of the visual field that accompanies severe oxygen lack is a familiar symptom. It may readily be demonstrated by producing local

anoxia of the retina by means of firm pressure applied to the eyeball by the fin[illegible] sufficient to stop retinal circulation. In about a minute the visual field darkens perceptibly, becomes tunnel-like and finally vision in the affected eye fails entirely. Sight is restored completely a few seconds after the release of the pressure, just as the graying-out at high altitude disappears promptly upon administration of oxygen.

Mild degrees of anoxia ordinarily have no noticeable visual effect. Nevertheless, the visual apparatus is very sensitive to oxygen deprivation. At ordinary daylight levels of illumination there is ample light for all visual tasks, and the slight darkening of the visual field that accompanies mild anoxia can only be demonstrated by special experiments, and is of no practical importance. At night, however, loss of visual sensitivity, even following a slight degree of anoxia, may be serious. At 18,000 feet the visual threshold is approximately double its value for the same observer at sea level, or when breathing oxygen. At this altitude the visual range for objects silhouetted against the night sky would, therefore, be reduced to two-thirds the value it should have if there were no oxygen want. Effects on the visual threshold are greatest above 12,000 feet, but small changes can be detected at lower altitudes by careful measurement. One might therefore conclude that important night operations requiring the maximum visual sensitivity demand the use of oxygen immediately upon take-off.

The rate of dark adaptation following exposure to a bright light appears to be unaffected by anoxia. To be sure, it takes a longer time for the anoxic retina to recover a given degree of sensitivity to light, but this is merely the expression of generally increased thresholds which raise the entire curve of dark adaptation a constant amount on a logarithmic scale. This has been interpreted as indicating that oxygen lack acts more strongly on neural mechanisms of the visual centers than on the photochemical system of the receptor cells. Both the rod and the cone segments of the dark adaptation curve are affected by anoxia to nearly the same degree.

The terminal rod threshold of the completely dark adapted eye follows changes in oxygen content of the inspired air with considerable rapidity, requiring only a few minutes to come to equilibrium. It has been reported that effects of anoxia on the visual threshold can be counteracted to some extent by the ingestion of glucose. The acid base balance as modified by hyperventilation and by breathing CO_2 likewise affects the visual threshold, and can counteract or increase the effects of anoxia.

Not only is the absolute minimum detectable intensity of light altered by anoxia, but discrimination of various shades of contrast is likewise affected adversely. This is noticeable, however, only when the lighting is poor. In good illumination intensity descrimination is relatively insensitive to moderate degrees of anoxia. Operations at dawn or dusk, therefore, necessitate stricter oxygen regulation than may be necessary in broad daylight. On the other hand, there are noticeable effects of anoxia at quite high illumination. The discrimination of flicker is an example: measurements of the flash rate at which flicker is just detectable provide a laboratory method for demonstrating moderate degrees of anoxia at high levels of illumination.

Perhaps the most striking subjective visual symptom of severe anoxia noticeable at high levels of illumination is the shrinkage of the visual fields. Although distinctly noticeable only when anoxia is well advanced, measurements of the visual field indicate that the effect is also present in mild degrees of anoxia. Extreme anoxia produces tunnel vision, the small region around the macula being the last part of the retina to loose its sensitivity. Evidently the central cone mechanism is the most resistant to effects of anoxia although the dark adapted threshold of foveal cones measured by deep red light is just as sensitive to oxygen deprivation as that of the rods.

Anoxia almost certainly affects all of the neurones of the visual pathway to some extent. Visual sense cells deprived of oxygen temporarily lose their

ability to initiate nerve impulses in response to illumination. However, the strictly photochemical part of their mechanism cannot be seriously impaired by anoxia, for light and dark adaptation have been shown to take place in the retina rendered completely unresponsive to light by anoxia from occlusion of retinal circulation. Retinal ganglion cells cease discharging impulses in their optic nerve fibers at a stage of anoxia which does not entirely obliterate all electrical activity of the retina. This indicates, though it does not prove, that the neural organization of the retina is particularly susceptible to affects of anoxia. On the whole it seems reasonable to suppose that the effects of anoxia on vision are principally the result of interference with the highly organized neural mechanisms both of the retina and of the higher visual centers.

H. K. Hartline

* * * * *

CONTROL OF INCAPACITATING EFFECTS OF DECOMPRESSION.

I. Selection Procedures

Only two symptoms of decompression sickness are considered to be incapacitating. One is a marked degree of pulmonary irritation which may develop into an incapacitating pain. This is believed to be caused by gas bubbles lodging in the pulmonary capillaries and thus impeding the circulation to the lungs. The second incapacitating effect of rapid exposure to low pressure is pain in or around a joint. This is also attributed to gas bubbles in the tissues or blood vessels around the joint. These two major symptoms of decompression sickness, usually called the "chokes" and "bends" are frequently employed as criteria for estimating a man's decompression tolerance.

It is well known that some men when decompressed in a chamber may not develop symptoms at a time when others are incapacitated. But it is now an equally

familiar observation that this individual tolerance varies from test to test. Whereas 20-30% of a group of men may be forced to descend during each of several four-hour tests at 38,000 feet the same men do not constitute the failures in each test. This fact has made classification of men for high altitude training a difficult problem.

Repeated tests on the same men have been made in several laboratories using different "flight" schedules. The subjects were classified in each test as passed or failed. The results of those several investigations establish beyond any doubt that by successive tests it is possible to separate men into groups in accordance with the probability of their being incapacitated by decompression. For example, as a result of repeated tests for three hours at 38,000 feet equival altitude men can be divided into two groups such that the probability of "bends" in crews chosen from the one group is much less than that for crews made up from the relatively immune group

These studies proved that a single test in a decompression chamber will serve to select a population of cadets in which the probability of occurrence of bends or chokes is much reduced in comparison with that for unselected men. However, a single test of three hours at 38,000 feet would eliminate many relatively immune men and admit many susceptible ones. To improve the selectivity of the single test new variables, such as low temperature, were introduced into the flight schedule.

When the tests are made at 10°F. it was observed that "bends" symptoms appeared earlier while the incidence of chokes was markedly reduced, compared to results at ordinary temperatures. The relative susceptibility of men to bends was unchanged at these low temperatures. These tests suggest that "chokes" should not be employed to eliminate a man from high altitude work unless he is susceptible at temperatures actually encountered inside a plane above 30,000 feet.

Recent experiments on decompressed frogs showed that a multitude of bubbles appeared in the venous blood when the leg muscles were stimulated. The observation was confirmed in a mammalian preparation. Simultaneously an independent report from another laboratory stated that exercise at 38,000 feet produced symptoms of bends in all tested men in a very short time. These facts suggested that a graded amount of exercise might be an important adjunct to the existing routine decompression test.

In one such test schedule the subjects were taken to 38,000 feet for a maximum stay of three hours. The exercise consisted of three slow knee-bends or "squats" followed by the lifting of a pair of weights (oxygen cylinder caps) from the floor to over-head three times in succession. This exercise was repeated every ten minutes. The incidence of incapacitating bends was much higher under these conditions when compared with a similar test without exercise. The onset of symptoms was early and all the men who descended were forced down in about two hours. Furthermore, the first test gave a sharper separation of men into two groups than does the test performed on subjects at rest. The total number of subjects was small (20), but the evidence suggests that the introduction of the proper amount of exercise into the flight schedule will shorten the time for each test and make a more efficient selection of relatively immune subjects.

It is to be recognized that at present the "true" susceptibility of a man to decompression pain is that established by several tests under the same conditions. The success of any testing procedure such as the one just discussed is based upon the accuracy with which this "true" susceptibility of a subject is thereby revealed. There are, however, no data upon which to evaluate the effectiveness of these tests in eliminating bends as a problem under operational conditions.

Protection by nitrogen elimination will be discussed in the following issue.

Frank Brink, Jr.